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Wu

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(54) **METHOD FOR HANDLING PERIODIC STATUS REPORT TIMER AFTER AN RLC RE-ESTABLISHMENT IN A WIRELESS COMMUNICATIONS SYSTEM**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

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Related U.S. Application Data

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(51) **Int. Cl.**
H04J 3/16 (2006.01)
H04J 3/14 (2006.01)

(52) **U.S. Cl.** **370/350**; 370/500

(58) **Field of Classification Search** 370/350, 370/500

See application file for complete search history.

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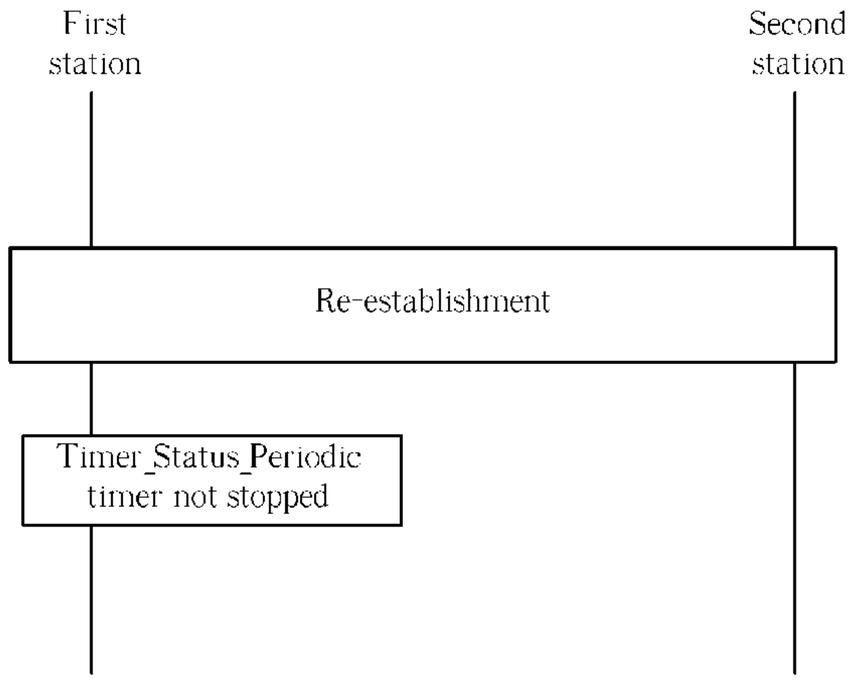
(57) **ABSTRACT**

A method for handling a Timer_Status_Periodic timer in a wireless communications system includes starting the Timer_Status_Periodic timer for a Radio Link Control Acknowledged Mode (RLC AM) entity, performing a re-establishment procedure for the RLC AM entity, and not stopping the Timer_Status_Periodic timer after re-establishment of the RLC AM entity.

2 Claims, 4 Drawing Sheets



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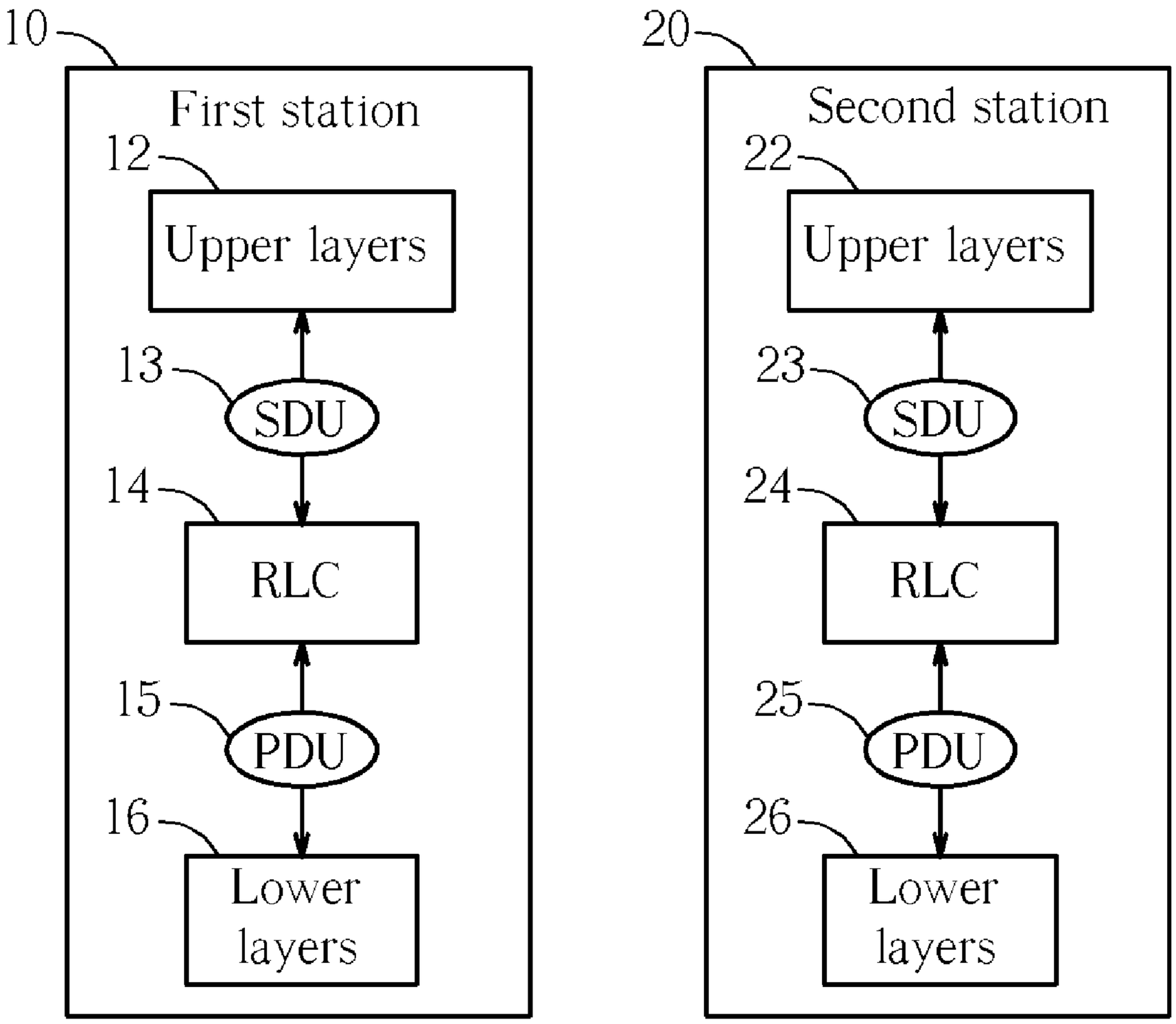

Fig. 1 Prior art

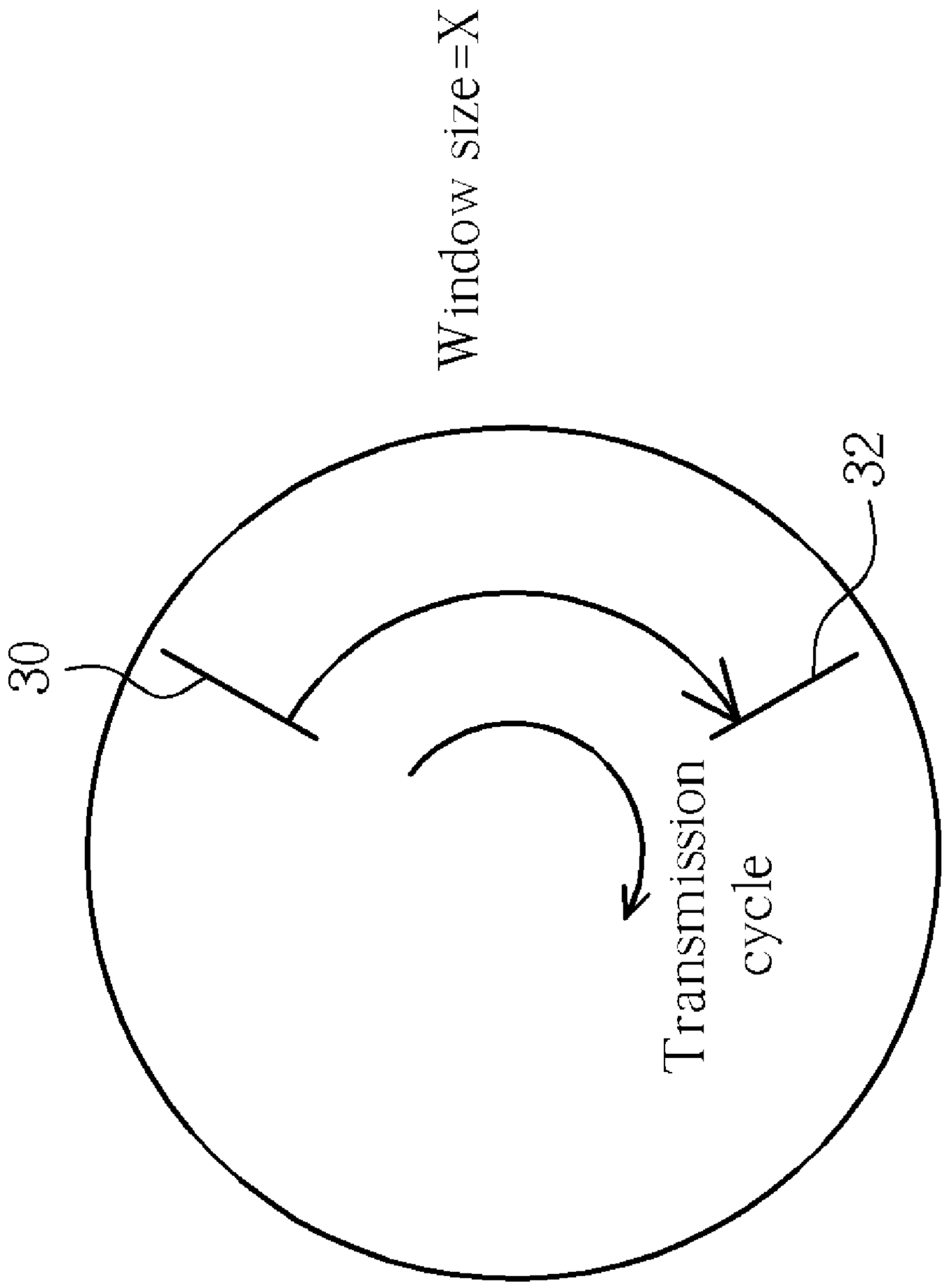

Fig. 2 Prior art

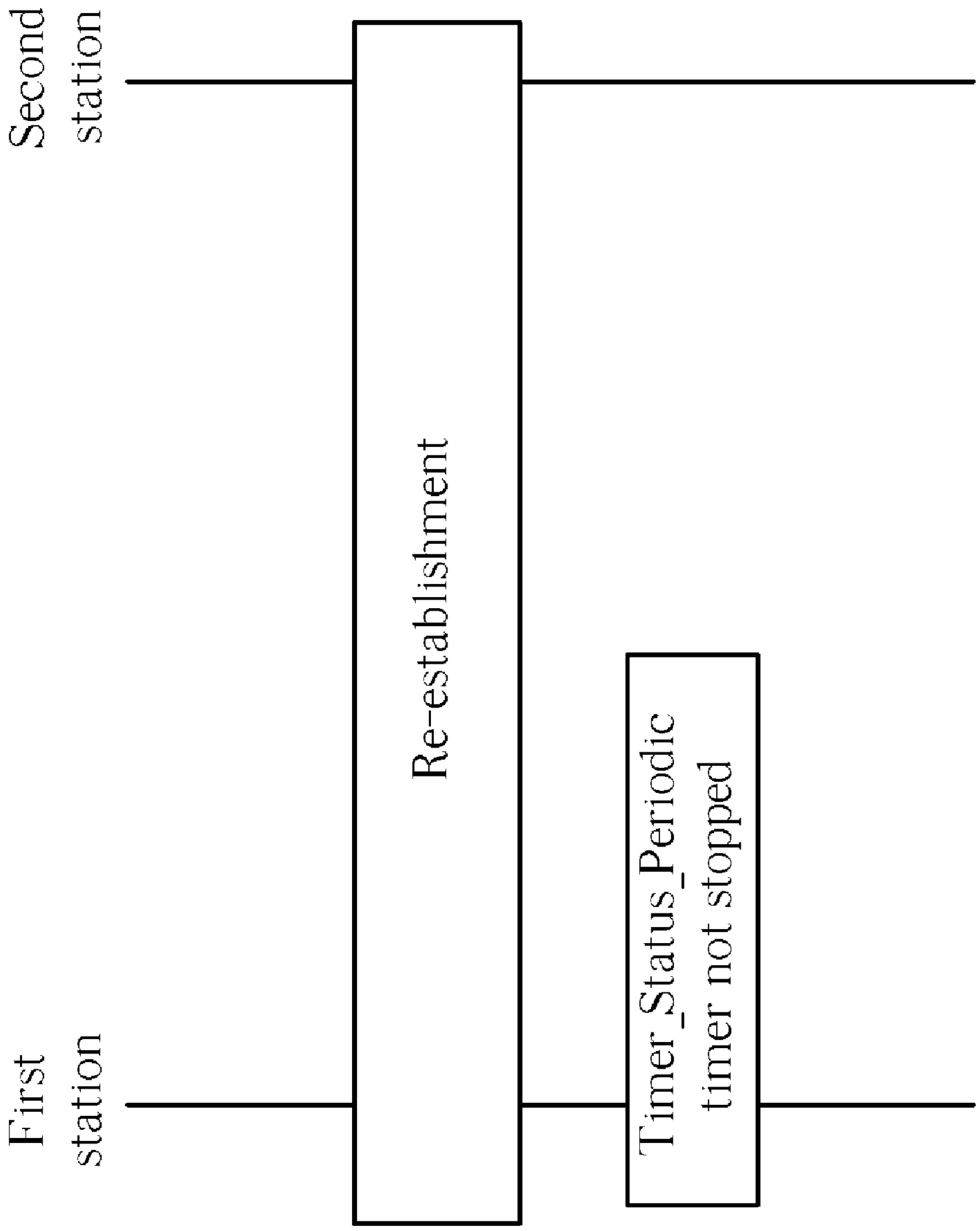
Second station
Re-establishment
Timer_Status_Periodic timer not stopped
First station

Fig. 3

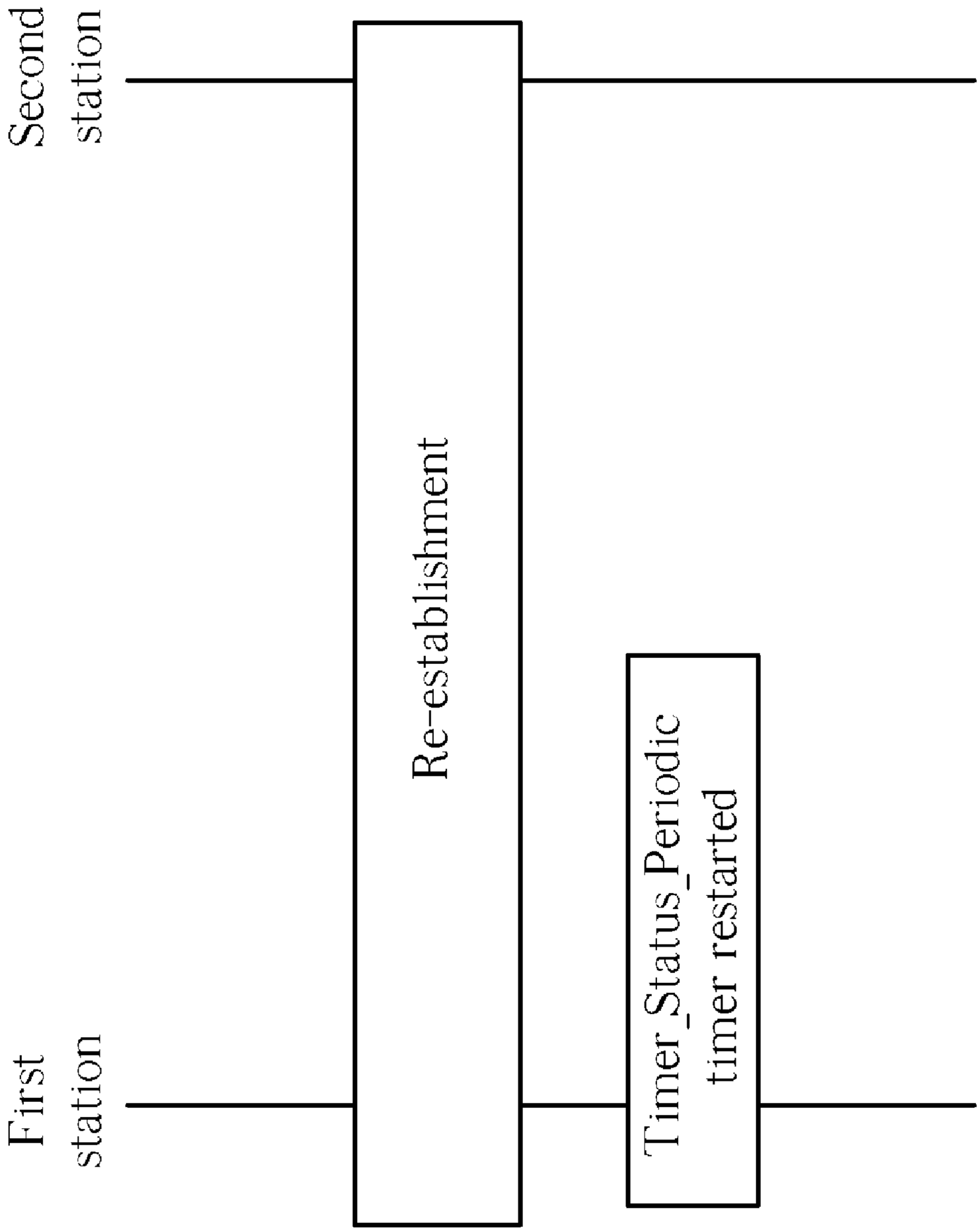
Second station
Re-establishment
Timer_Status_Periodic timer restarted
First station

Fig. 4

METHOD FOR HANDLING PERIODIC STATUS REPORT TIMER AFTER AN RLC RE-ESTABLISHMENT IN A WIRELESS COMMUNICATIONS SYSTEM

CROSS REFERENCE TO RELATED APPLICATIONS

This is a continuation application of application Ser. No. 10/064,747, filed Aug. 13, 2002, which is included in its entirety herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a method for handling timers in a wireless communications system, and more specifically, to a method for handling a Timer_Status_Periodic timer after an RLC re-establishment in a wireless communications system.

2. Description of the Prior Art

Technological advances have moved hand in hand with more demanding consumer expectations. Devices that but ten years ago were considered cutting edge are today obsolete. These consumer demands in the marketplace spur companies towards innovation. The technological advances that result only serve to further raise consumer expectations. Presently, portable wireless devices, such as cellular telephones, personal digital assistants (PDAs), notebook computers, etc., are a high-growth market. However, the communications protocols used by these wireless devices are quite old. Consumers are demanding faster wireless access with greater throughput and flexibility. This has placed pressure upon industry to develop increasingly sophisticated communications standards. The 3rd Generation Partnership Project (3GPP) is an example of such a new communications protocol.

Please refer to FIG. **1**. FIG. **1** is a simplified block diagram of the prior art communications model. In a typical wireless environment, a first station **10** is in wireless communications with one or more second stations **20**. The first station **10** is comprised of upper layers **12**, a radio link control (RLC) entity **14**, and lower layers **16** which are below the RLC **14**. In the following disclosure, all of the RLC entities are assumed to be RLC acknowledged mode (RLC AM) entities. The upper layers **12** can deliver messages to the RLC **14** through service data units (SDUs) **13**. The SDUs **13** may be of any size, and hold data that the upper layers **12** wish delivered to the second station **20**. The RLC **14** composes the SDUs **13** into one or more protocol data units (PDUs) **15**. Each PDU **15** of the RLC **14** is of a fixed size, and is delivered to the lower layers **16**. The lower layers **16** include the physical layer, which is in charge of transmitting data to the second station **20**.

The second station **20** shown has exactly the same basic structure as the first station **10**. The second station **20** also includes upper layers **22**, an RLC **24**, and lower layers **26**. Just as with the first station **10**, the second station **20** uses the upper layers **22** to transmit SDUs **23** to the RLC **24**, and uses the RLC **24** to transmit PDUs **25** to the lower layers **26**. The data transmitted by the first station **10** is received by lower layers **26** of the second station **20** and reconstructed into one or more PDUs **25**, which are passed up to the RLC **24**. The RLC **24** receives the PDUs **25** and from them assembles one or more SDUs **23**, which are then passed up to the upper layers **22**. The upper layers **22**, in turn, convert the SDUs **23** back into messages, which should be identical to the original messages that were generated by the first station **10**. In communication

systems, the terms SDU and PDU have broad meanings. For purposes of the following disclosure, the term "SDU" is used to indicate SDUs passed from the upper layers to the RLC, and the term "PDU" should be understood as PDUs passed from the RLC to lower layers. In addition, for simplicity the following disclosure will be written from the perspective of the first station **10**, unless otherwise noted.

The 3rd Generation Partnership Project (3GPP) specification 3GPP TS 25.322 V3.11.0 "RLC Protocol Specification has defined parameters, variables, timers, control PDUs, etc., for operations of the first station **10** and the second station **20**. According to the specification, in some circumstances, the RLC layers **14** and **24** must be re-established with an RLC re-establishment function. However, the specification does not specify how the timers should be handled during re-establishment. Due to this lack of guidelines, potential problems could develop due to the improper use of the timers.

Please refer to FIG. **2**. FIG. **2** is a phase diagram illustrating a transmission window of an RLC AM entity according to the prior art. During normal operation, the RLC AM entity **14** (transmitter) transmits acknowledged mode data (AMD) PDUs to the RLC AM entity **24** (receiver), and each PDU is marked with a sequence number (SN). The SNs have a fixed bit length of n bits. In the preferred embodiment, the bit length n is 12. Hence, the SNs have a range of values from zero to 4095 ($2^{12}-1$). The phase diagram for SNs can thus be represented by a circle. For the following example, point **30** is the sequentially lowest transmitter PDU SN value waiting for acknowledgment from the receiver in the form of a STATUS PDU, which contains information on which PDUs have been acknowledged. In other words, point **30** marks the beginning of the transmitting window. In this example, assume a window size=X. Point **32** marks the highest PDU SN value of an AMD PDU that has been sent so far. Therefore, in order to prevent the transmitting window from filling up, the difference of PDU SN values at point **32** and point **30** has to be less than X. Otherwise, the transmitting window fills up, and deadlock occurs. Deadlock can occur if AMD PDUs sent from the transmitter to the receiver are not properly acknowledged by the receiver. This would cause point **30** to remain stationary, and the difference between point **32** and point **30** would eventually equal the maximum window size of X.

As mentioned in the specification 3GPP TS 25.322 V3.11.0, a Timer_Status_Periodic timer is used by the RLC AM entity **24** to send STATUS PDUs to its peer RLC AM entity **14**. When the Timer_Status_Periodic timer of the RLC AM entity **24** expires, a STATUS PDU is generated and sent to the RLC AM entity **14**. This STATUS PDU informs the RLC AM entity **14** which AMD PDUs have been acknowledged. Since the specification does not specify how the Timer_Status_Periodic timer should be handled during re-establishment, the Timer_Status_Periodic timer may be stopped by the RLC entity upon reception of a re-establishment request, and never restarted after the re-establishment procedure. Therefore, the Timer_Status_Periodic timer does not ever get started again, and cannot trigger a poll to the peer RLC AM entity **14** upon expiration of the timer. This means that AMD PDUs with lower SN values indicated by point **30** in FIG. **2** will never be acknowledged. Since point **30** never moves, eventually the difference between point **32** and point **30** will equal the transmission window size of X. Thus, because the timer remains stopped, deadlock occurs, and the RLC AM entity **24** cannot transmit additional PDUs to the peer RLC AM entity **14**.

Therefore, since the current 3GPP specification does not specify how the Timer_Status_Periodic timer should be

handled during re-establishment, deadlock can occur and quality of service may be reduced substantially.

SUMMARY OF THE INVENTION

It is therefore a primary objective of the claimed invention to provide a method for handling a Timer_Status_Periodic timer after an RLC re-establishment in a wireless communications system in order to solve the above-mentioned problems.

According to the claimed invention, a method for handling a Timer_Status_Periodic timer in a wireless communications system includes starting the Timer_Status_Periodic timer for a Radio Link Control Acknowledged Mode (RLC AM) entity, performing a re-establishment procedure for the RLC AM entity, and not stopping the Timer_Status_Periodic timer after re-establishment of the RLC AM entity.

These and other objectives of the present invention will no doubt become obvious to those of ordinary skill in the art after reading the following detailed description of the preferred embodiment that is illustrated in the various figures and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a simplified block diagram of the prior art communications model.

FIG. **2** is a phase diagram illustrating a transmission window of an RLC AM entity according to the prior art.

FIGS. **3** and **4** are message sequence charts illustrating handling of the Timer_Status_Periodic timer during a re-establishment function according to the present invention.

DETAILED DESCRIPTION

Please refer to FIGS. **3** and **4**. FIGS. **3** and **4** are message sequence charts illustrating handling of the Timer_Status_Periodic timer during a re-establishment function according to the present invention. After the RLC AM entity **14** is re-established by upper layers, the present invention method includes not stopping the Timer_Status_Periodic timer as shown in FIG. **3**. Alternately, as shown in FIG. **4**, the present invention method includes restarting the Timer_Status_Periodic timer.

Thus, for a re-establishment function, the handling of the Timer_Status_Periodic timer can be summarized as follows: after re-establishment, the Timer_Status_Periodic timer is not stopped or is restarted. By not stopping or restarting the Timer_Status_Periodic timer, the RLC AM entity **14** will continue to be able to send STATUS PDUs to its peer RLC AM entity **24** after the RLC AM entity **14** has been re-established, and will prevent deadlock from occurring.

Compared to the prior art, the present invention provides steps for handling the Timer_Status_Periodic timer after re-establishment of the RLC AM entity. Therefore, the present invention will prevent RLC AM entities from experiencing deadlock, and will help maintain the quality of service.

Those skilled in the art will readily observe that numerous modifications and alterations of the device and method may be made while retaining the teachings of the invention. Accordingly, the above disclosure should be construed as limited only by the metes and bounds of the appended claims.

What is claimed is:

1. A method for handling a Timer_Status_Periodic timer in a wireless communications system, the method comprising:

starting the Timer_Status_Periodic timer for a Radio Link Control Acknowledged Mode (RLC AM) entity;

performing a re-establishment procedure for the RLC AM entity; and

not stopping the Timer_Status_Periodic timer after re-establishment of the RLC AM entity.

2. The method of claim **1** further comprising maintaining a value of the Timer_Status_Periodic timer and maintaining operation of the Timer_Status_Periodic timer after re-establishment of the RLC AM entity.

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